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**Huang et al.**

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(45) **Date of Patent: May 10, 2016**

(54) **AUTOMATIC PILL GRASPING APPARATUS AND METHOD**

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(73) Assignee: **HON HAI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

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(30) **Foreign Application Priority Data**

Jul. 29, 2013 (TW) ..... 102127189 A

(51) **Int. Cl.**

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|---|---|
| ***G07F 11/54*** | (2006.01) |
| ***B25J 9/16*** | (2006.01) |
| ***B25J 15/06*** | (2006.01) |
| ***A61J 7/00*** | (2006.01) |
| *A61J 7/04* | (2006.01) |

(52) **U.S. Cl.**

CPC ..... ***B25J 9/1694*** (2013.01); ***A61J 7/0076*** (2013.01); ***B25J 15/0616*** (2013.01); *A61J 7/04* (2013.01); *A61J 2200/70* (2013.01)

(58) **Field of Classification Search**

CPC . B65D 83/0409; B65D 83/0454; G07F 11/54
USPC ..... 221/211; 414/1, 2, 3, 4, 5, 6
See application file for complete search history.

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*Primary Examiner* — Patrick Mackey
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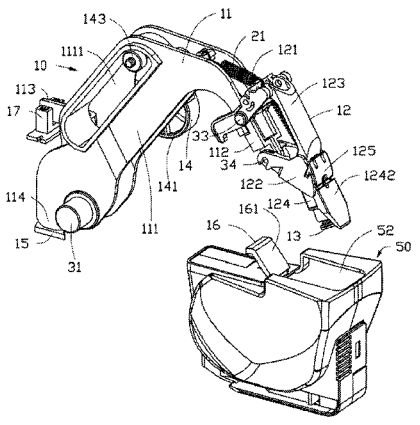
(57) **ABSTRACT**

A pill grasping method comprises rotating a grasping arm with a nozzle to a predetermined initial position driven by a driving mechanism, rotating a number of pill storage cases to position one of the pill storage cases with a set number of pills to a predetermined grasping pill position driven by an actuating mechanism, rotating the grasping arm to enter into the corresponding pill storage case, starting a pump to generate a vacuum in the nozzle for sucking a pill, and determining if an actual pressure value in a pipe connecting the nozzle to the pump is less than a predetermined pressure value. The grasping arm is rotated to the predetermined initial position when the actual pressure value is less than the predetermined pressure value.

**19 Claims, 22 Drawing Sheets**



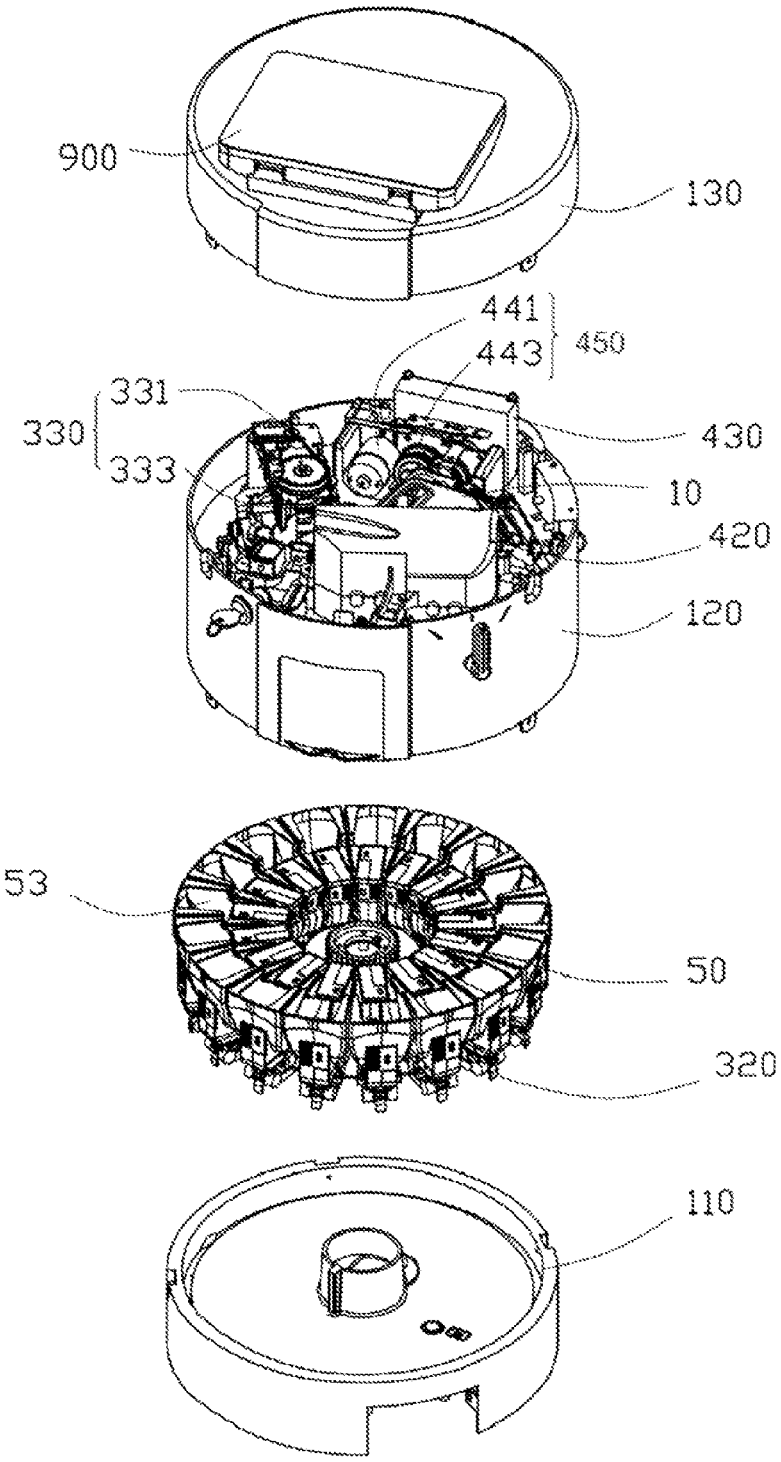



FIG. 1

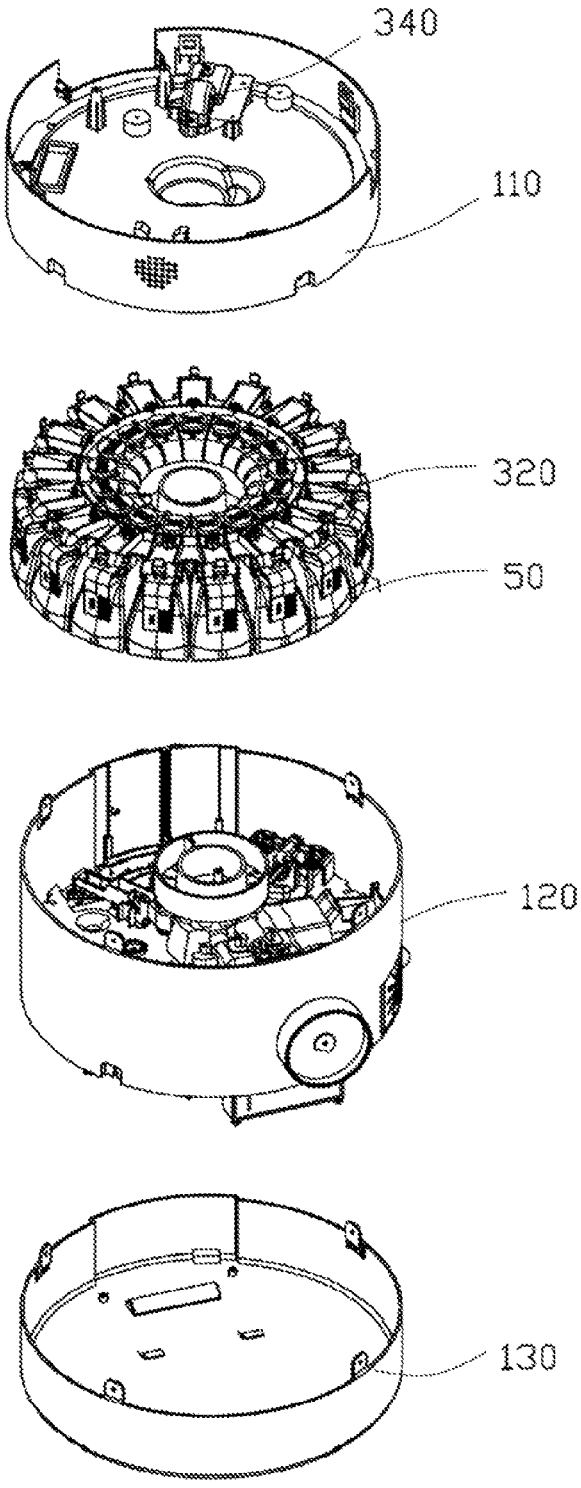



FIG. 2

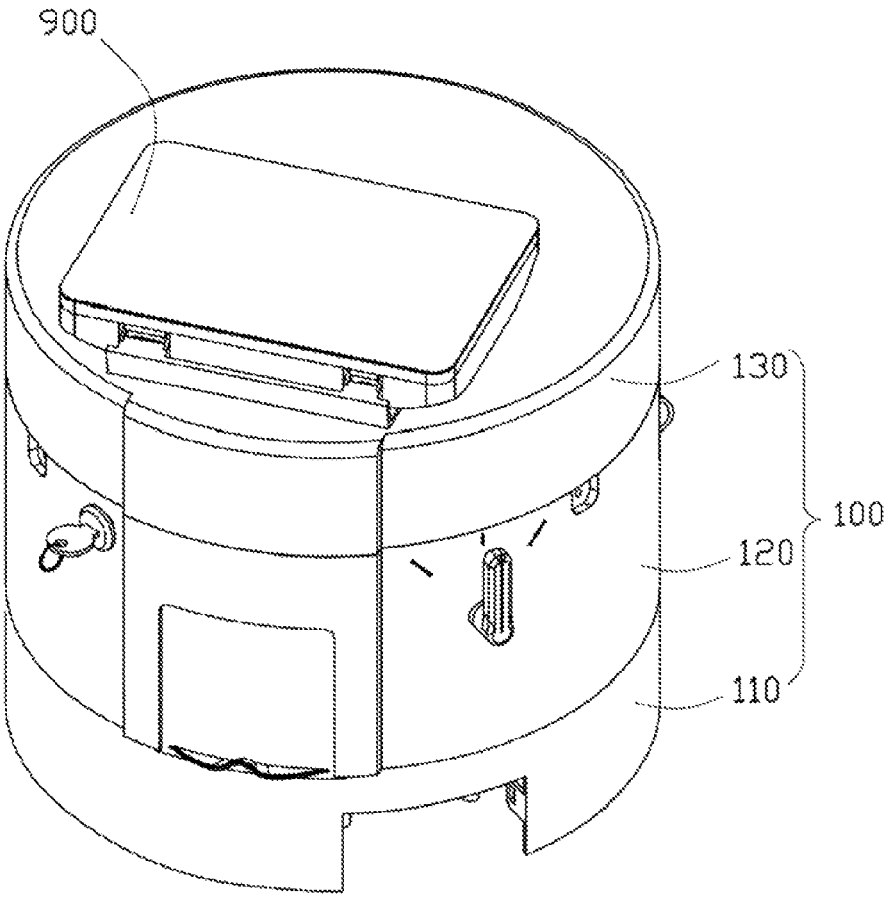



FIG. 3

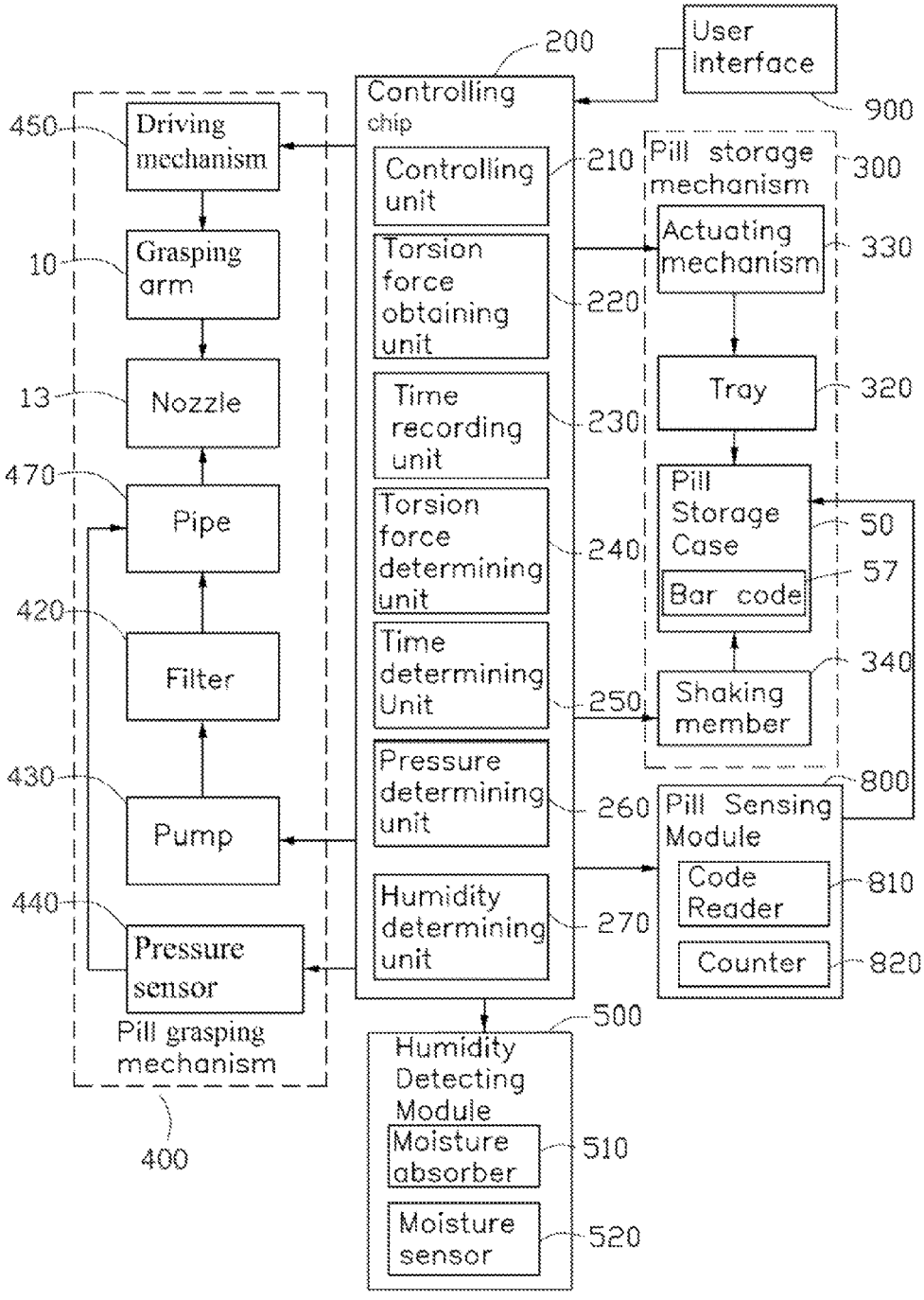

User interface
900
200
Controlling chip
Controlling unit
210
Torsion force obtaining unit
220
Time recording unit
230
Torsion force determining unit
240
Time determining Unit
250
Pressure determining unit
260
Humidity determining unit
270
Pill storage mechanism
300
Actuating mechanism
330
Tray
320
Pill Storage Case
50
Bar code
57
Shaking member
340
800
Pill Sensing Module
Code Reader
810
Counter
820
450
Driving mechanism
10
Grasping arm
13
Nozzle
470
Pipe
420
Filter
430
Pump
440
Pressure sensor
Pill grasping mechanism
400
500
Humidity Detecting Module
Moisture absorber
510
Moisture sensor
520

FIG. 4

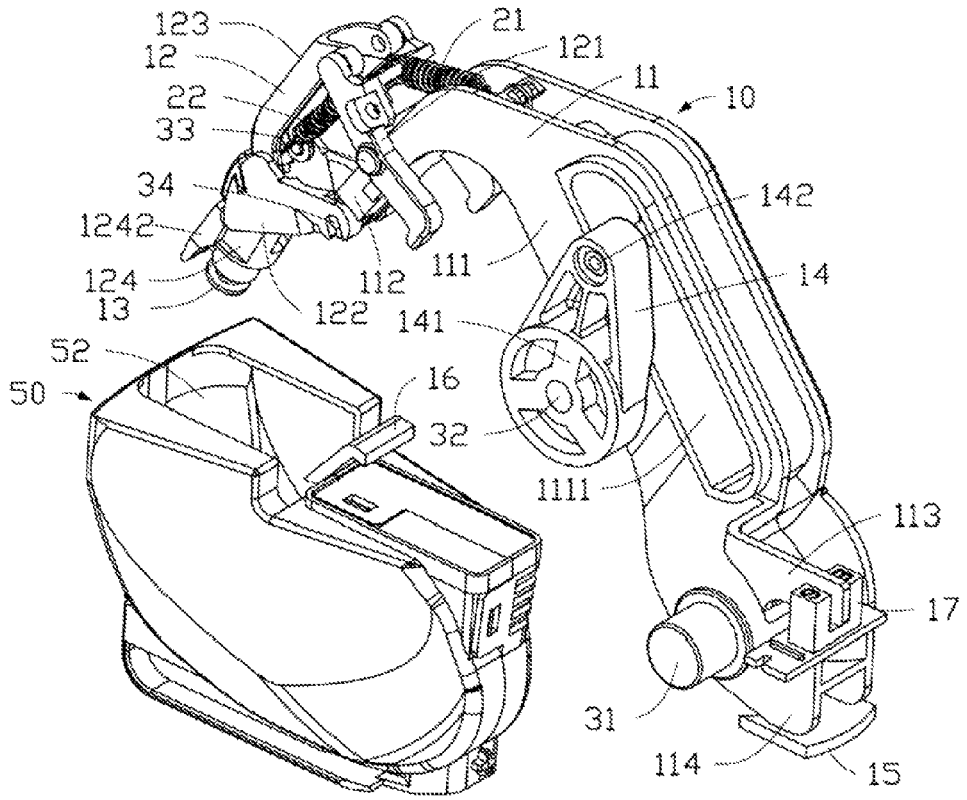

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FIG. 5

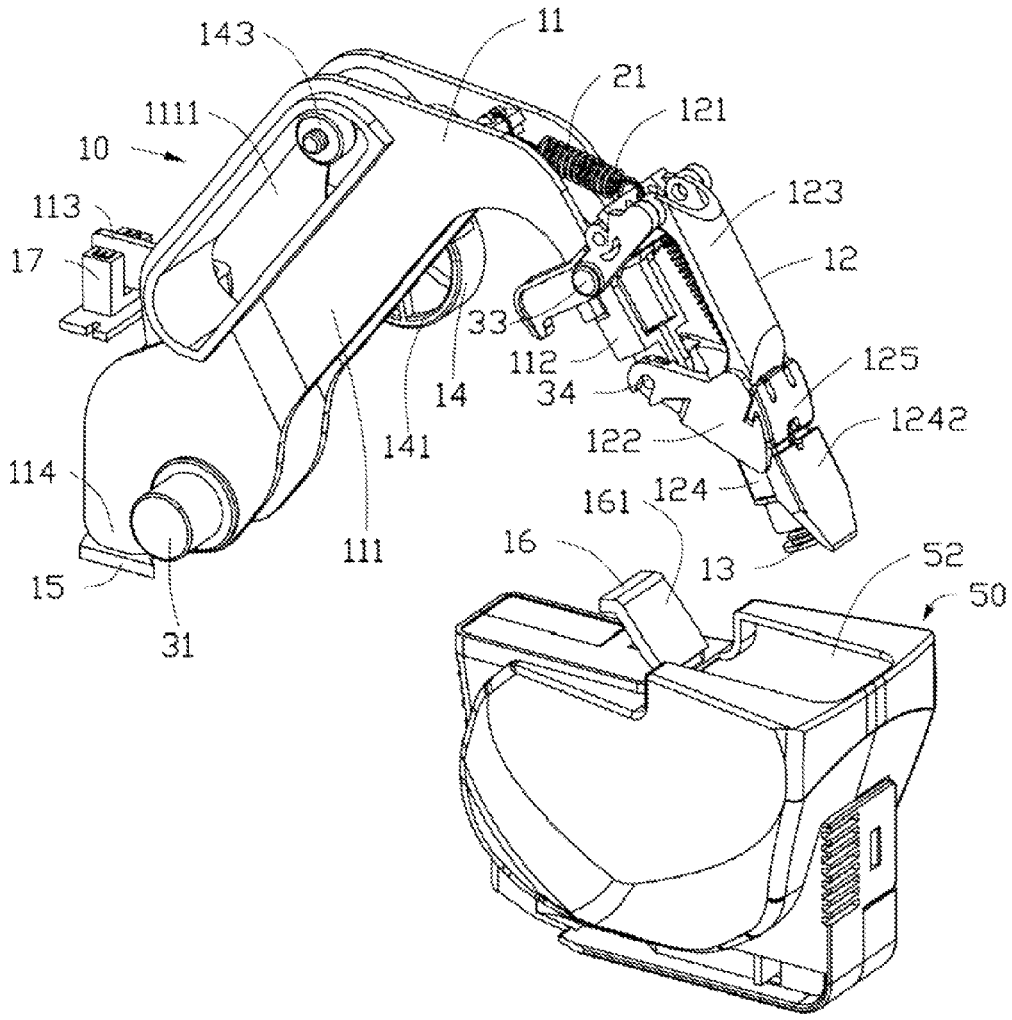
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FIG. 6

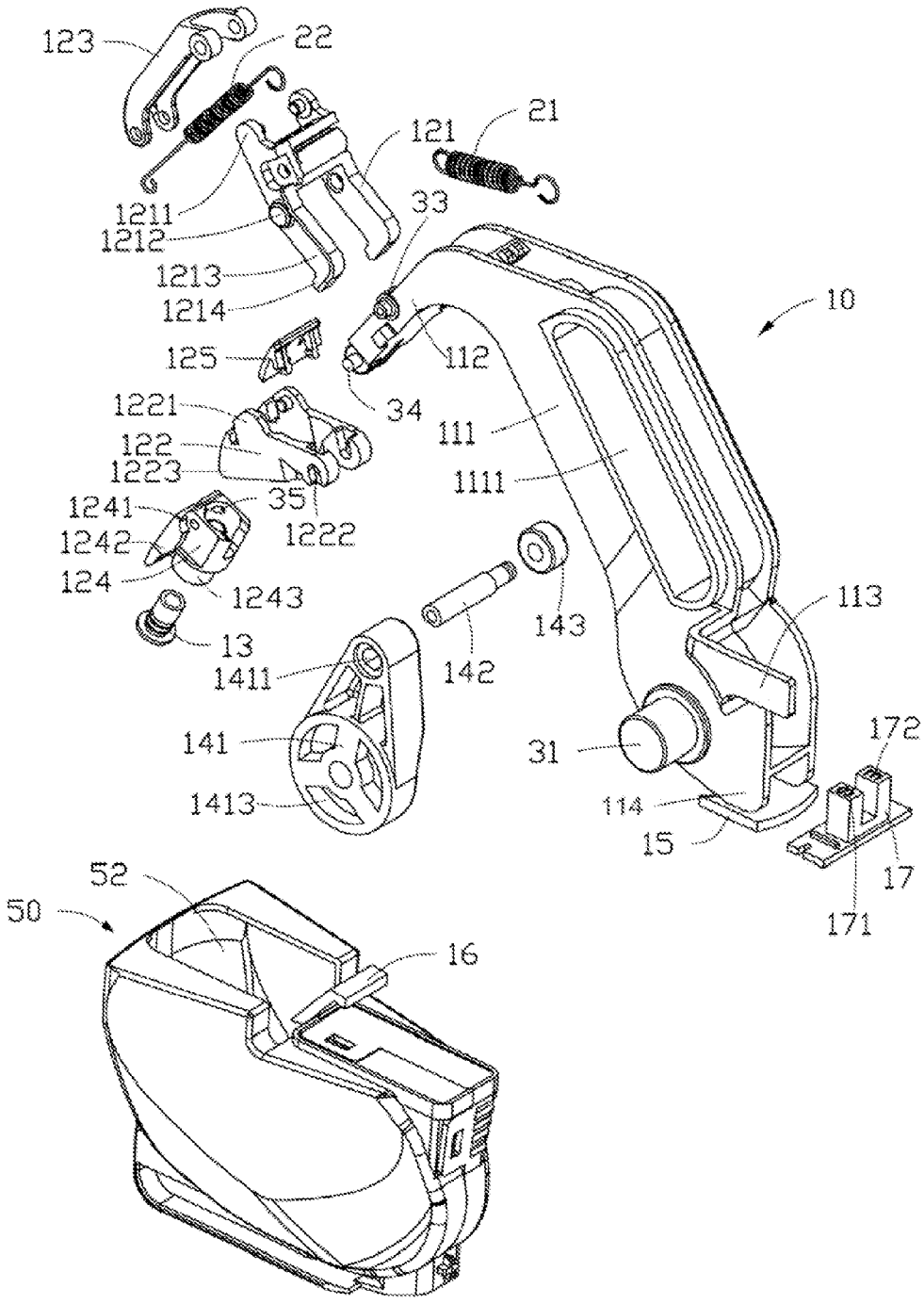
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FIG. 7

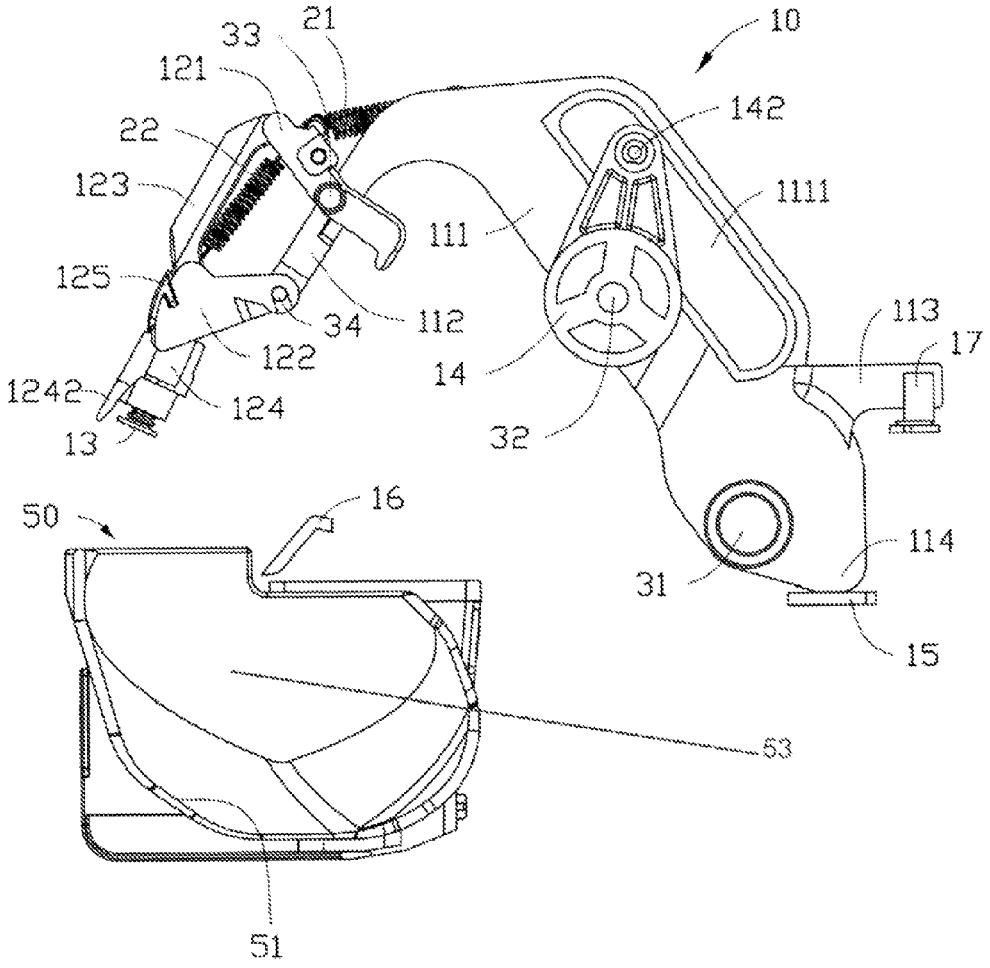
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FIG. 8

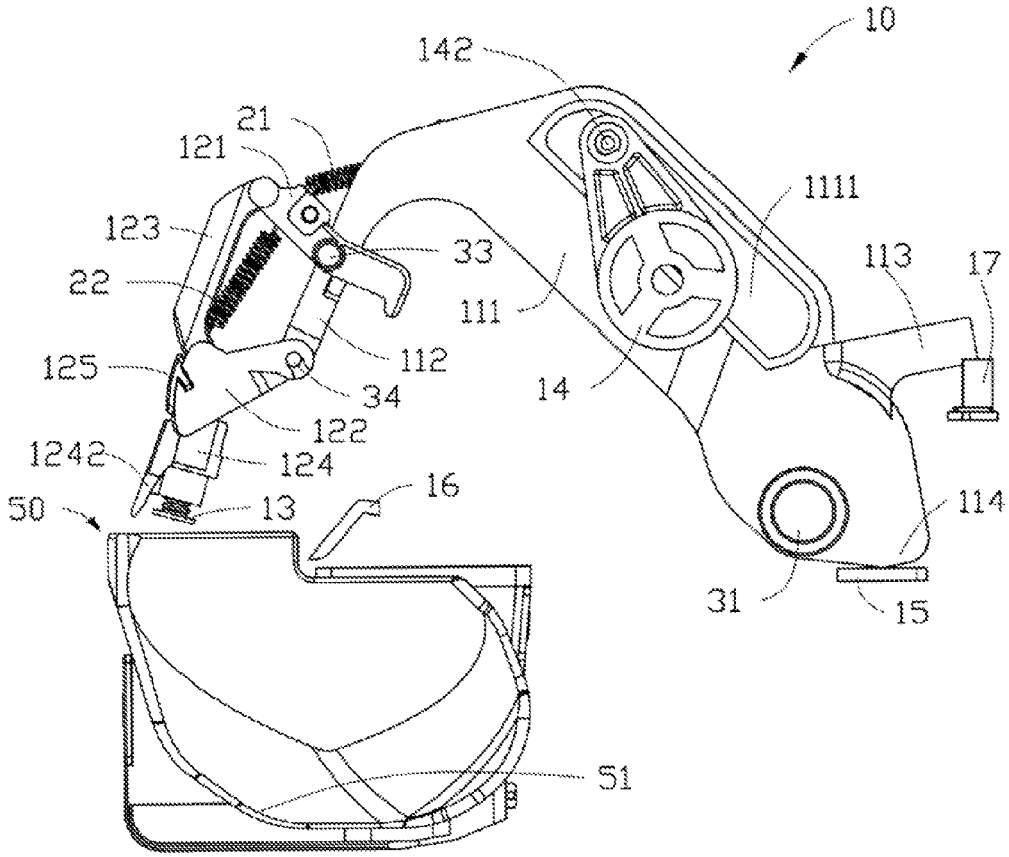
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FIG. 9

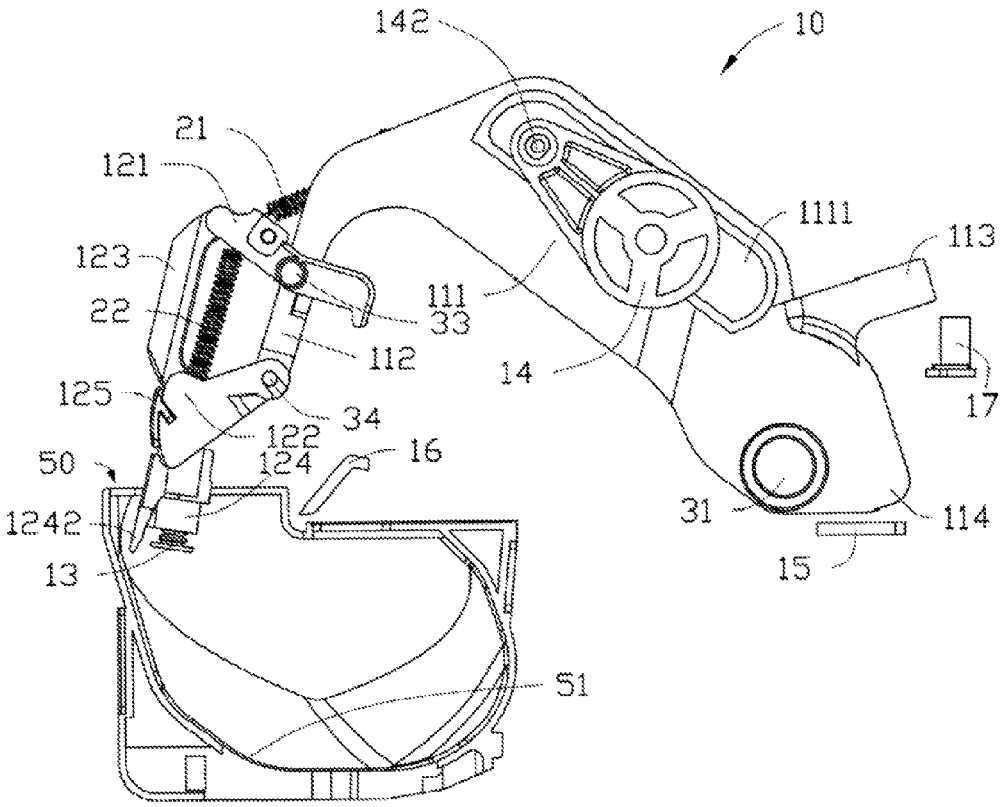
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FIG. 10

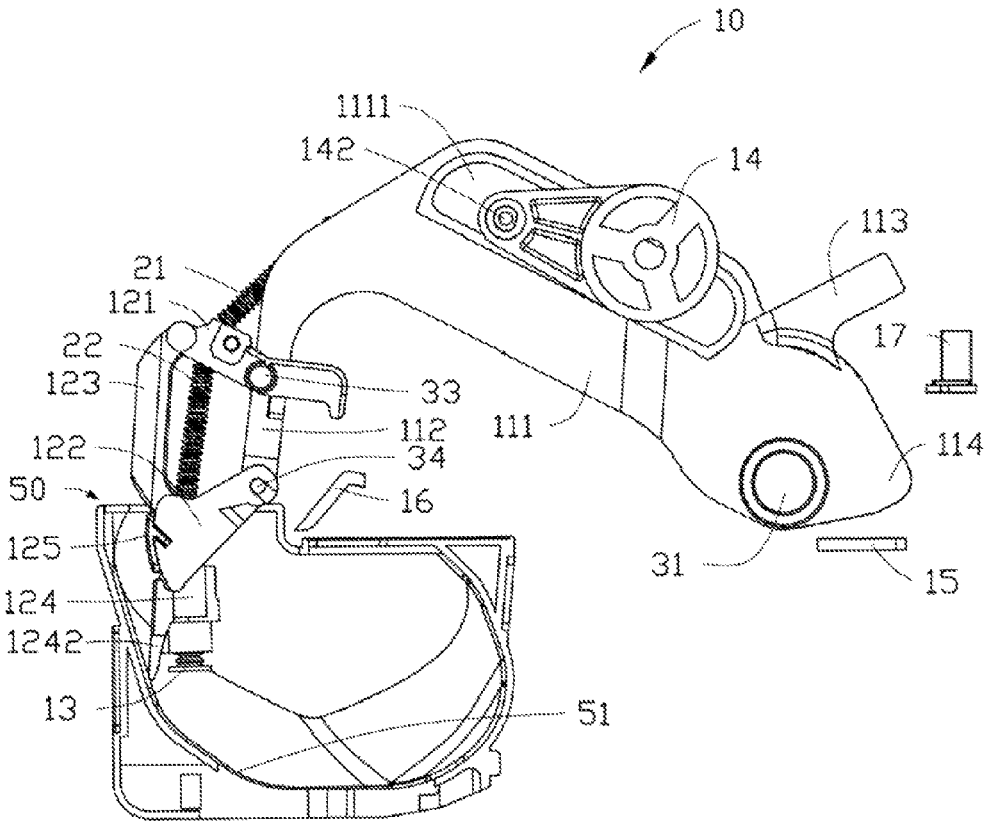
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FIG. 11

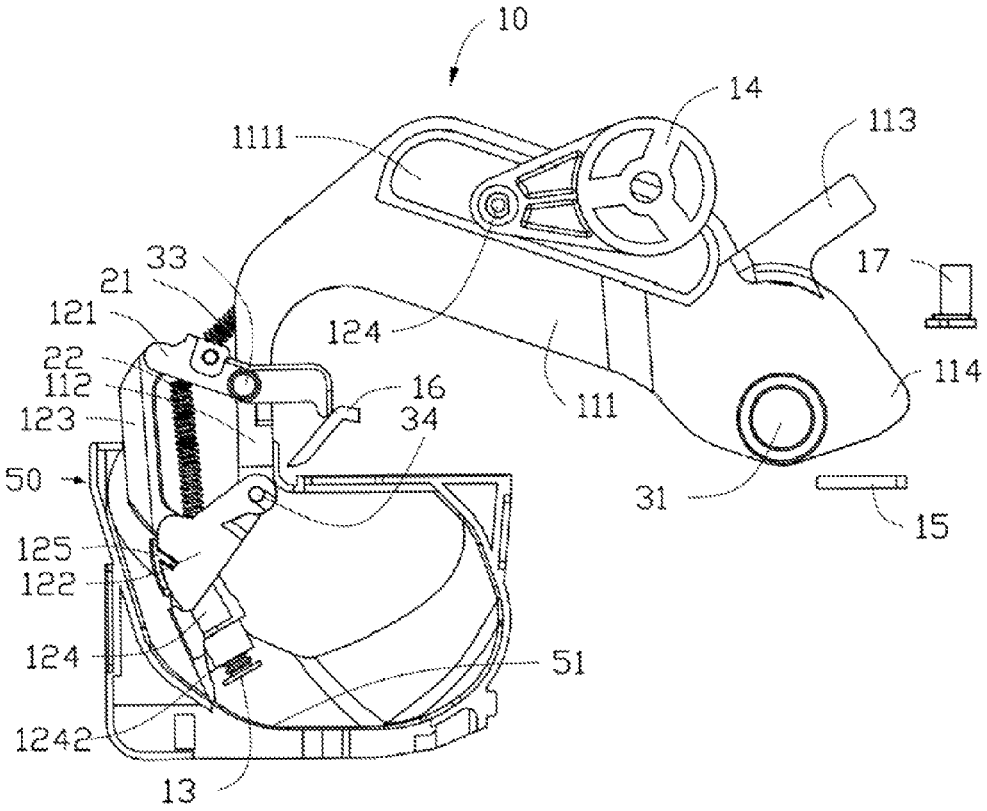
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FIG. 12

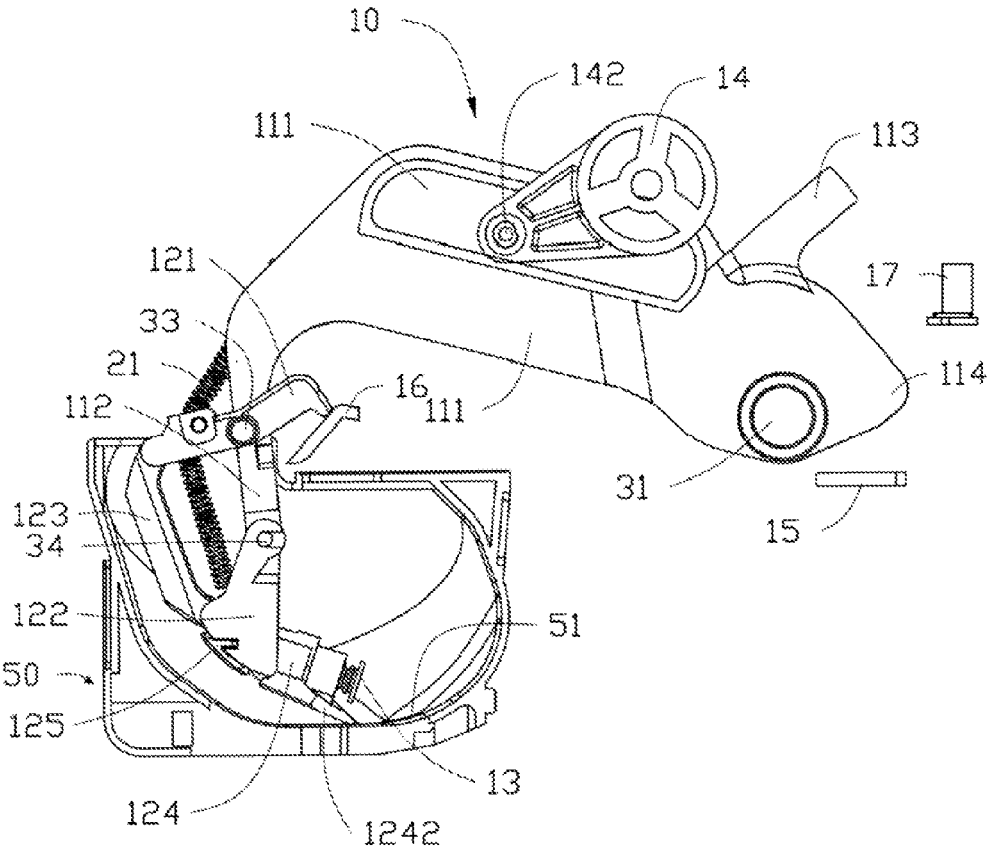
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FIG. 13

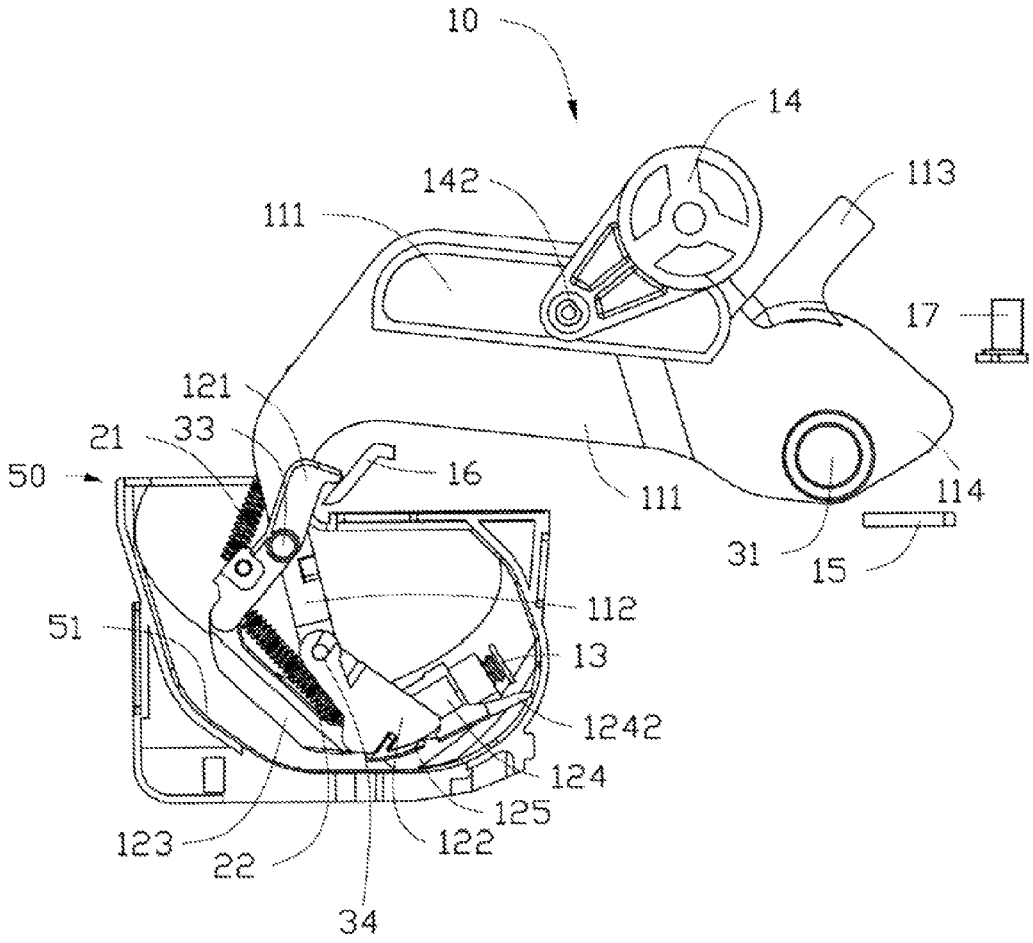
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FIG. 14

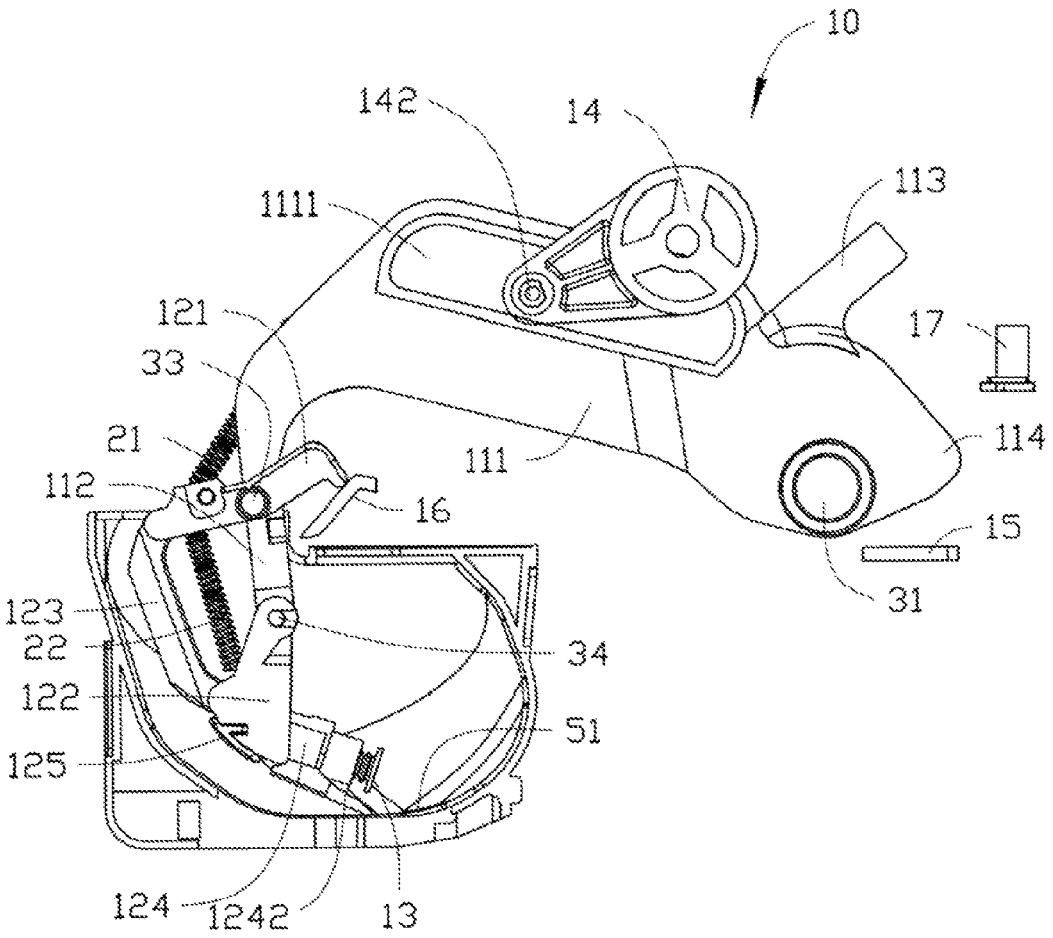
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FIG. 15

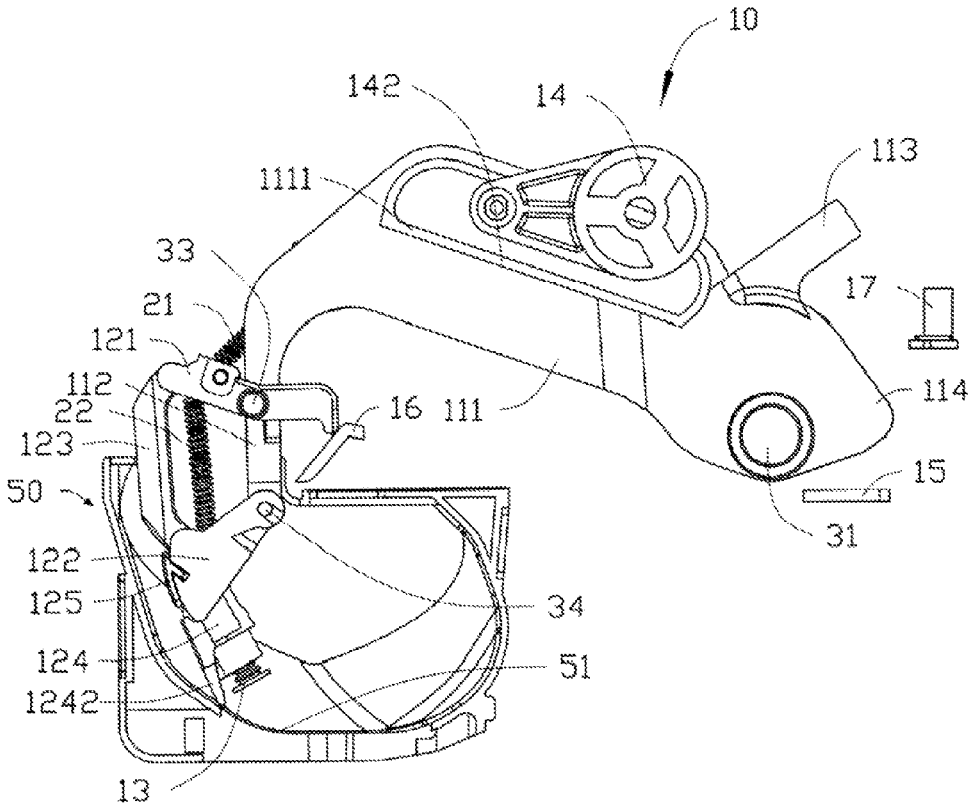
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FIG. 16

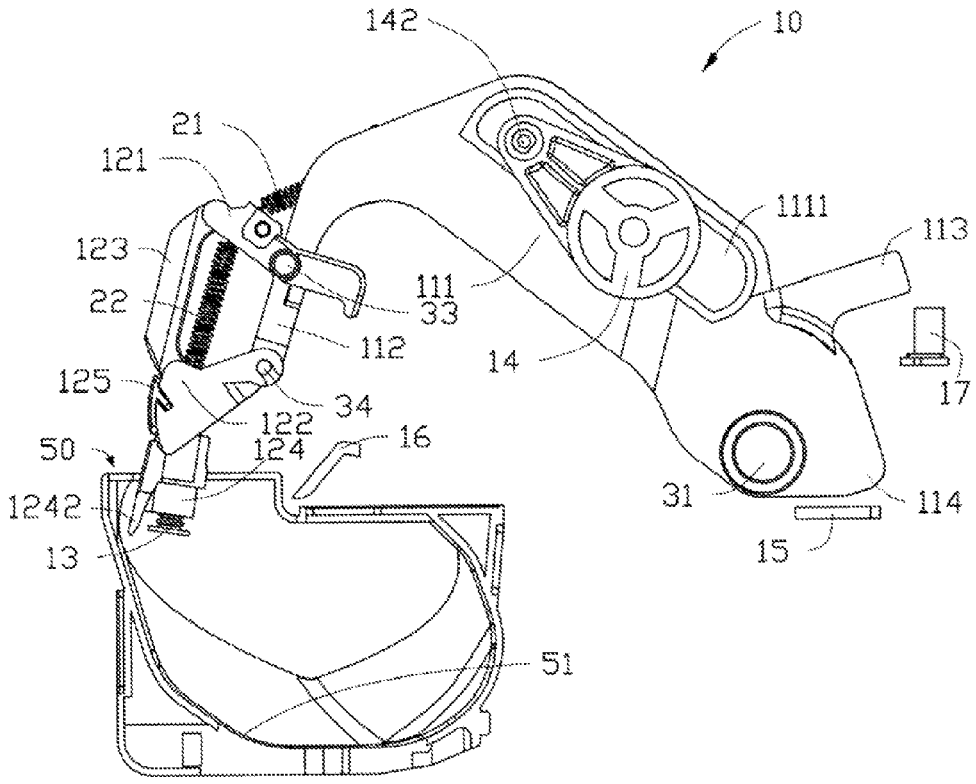
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FIG. 17

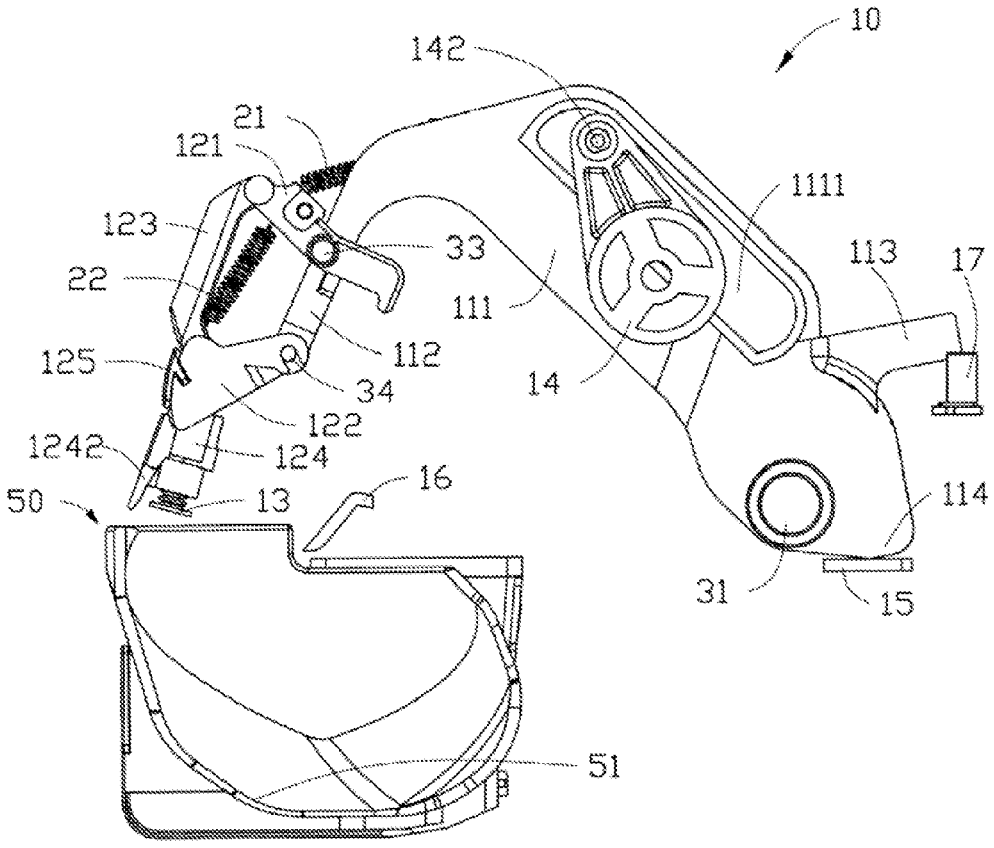
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FIG. 18

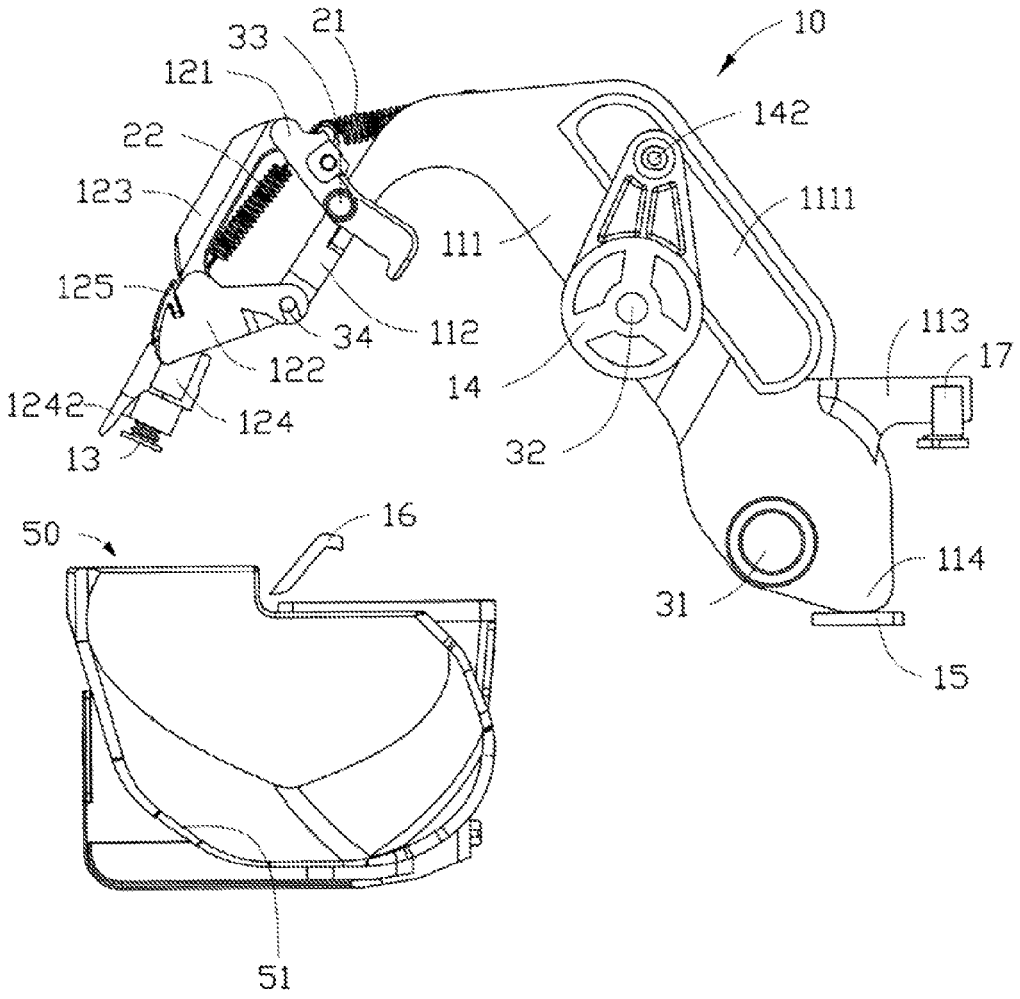
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FIG. 19

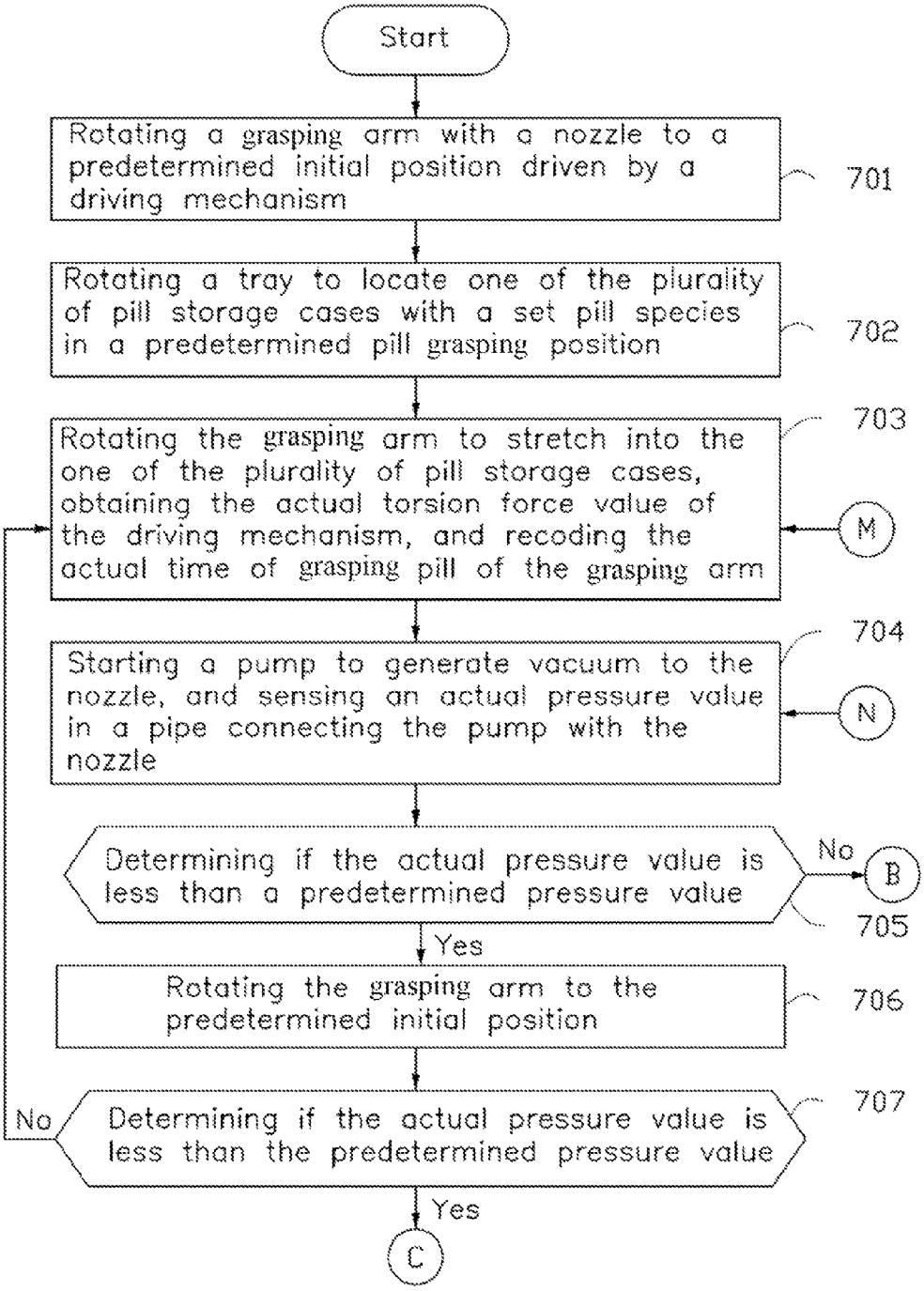
Start
Rotating a grasping arm with a nozzle to a predetermined initial position driven by a driving mechanism
701
Rotating a tray to locate one of the plurality of pill storage cases with a set pill species in a predetermined pill grasping position
702
Rotating the grasping arm to stretch into the one of the plurality of pill storage cases, obtaining the actual torsion force value of the driving mechanism, and recoding the actual time of grasping pill of the grasping arm
703
M
Starting a pump to generate vacuum to the nozzle, and sensing an actual pressure value in a pipe connecting the pump with the nozzle
704
N
Determining if the actual pressure value is less than a predetermined pressure value
No
B
705
Yes
Rotating the grasping arm to the predetermined initial position
706
Determining if the actual pressure value is less than the predetermined pressure value
707
No
Yes
C

FIG. 20

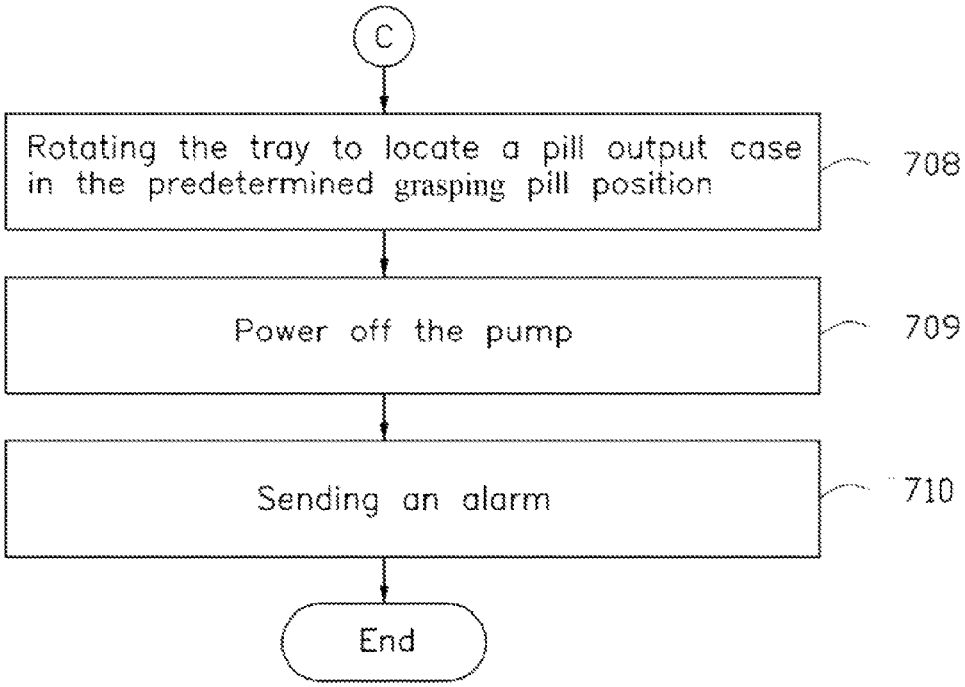
C
Rotating the tray to locate a pill output case in the predetermined grasping pill position
708
Power off the pump
709
Sending an alarm
710
End

FIG. 21

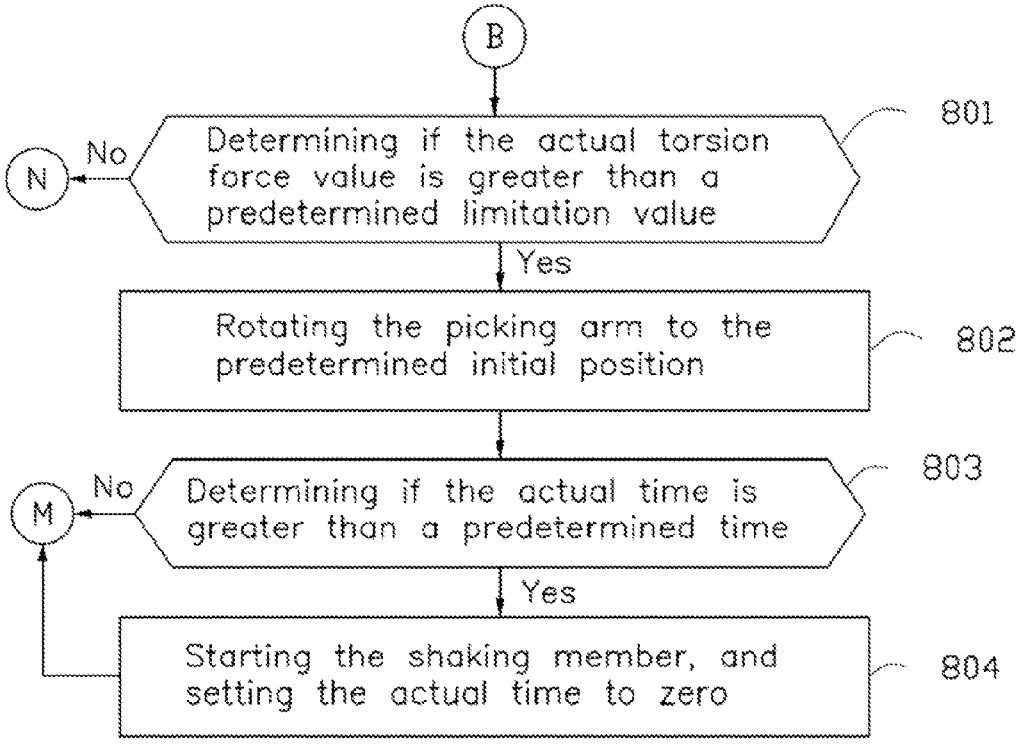
B
Determining if the actual torsion force value is greater than a predetermined limitation value
801
No
N
Yes
Rotating the picking arm to the predetermined initial position
802
Determining if the actual time is greater than a predetermined time
803
No
M
Yes
Starting the shaking member, and setting the actual time to zero
804

FIG. 22

# AUTOMATIC PILL GRASPING APPARATUS AND METHOD

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to Taiwan Patent Application No. 102127189 filed on Jul. 29, 2013 in the Taiwan Intellectual Property Office, the contents of which are hereby incorporated by reference. Relevant subject matter is disclosed in co-pending U.S. patent applications entitled "AUTOMATIC PILL GRASPING APPARATUS", Ser. No. 14/264,629, U.S. application Ser. No. [to be advised], filed on the same day as the present application.

## FIELD

The present disclosure generally relates to an automatic pill grasping apparatus and method.

## BACKGROUND

Automatic pill grasping apparatuses are commonly used to help individuals, such as the elderly or chronically ill, take medication at a given date and time. Pill dispensers often include a pill storage case for storing solid pills, and a pill grasping mechanism for grasping pills from the pill storage case.

## BRIEF DESCRIPTION OF THE DRAWINGS

Many aspects of the embodiments can be better understood with reference to the following drawings. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the embodiments. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the several views.

FIG. **1** is an isometric, exploded view of an embodiment of an automatic pill grasping apparatus.

FIG. **2** is similar to FIG. **1**, but showing the automatic pill grasping apparatus from another angle.

FIG. **3** is an assembled view of the automatic pill grasping apparatus of FIG. **1**.

FIG. **4** is a block diagram view of the automatic pill grasping apparatus.

FIG. **5** is an isometric view of an embodiment of a grasping arm and a pill storage case.

FIG. **6** is similar to FIG. **5**, but viewed from another aspect.

FIG. **7** is an exploded view of the grasping arm and the pill storage case of FIG. **5**.

FIG. **8** illustrates the grasping arm being in a predetermined position.

FIG. **9** illustrates the grasping arm starting being rotated in a counter clockwise direction.

FIG. **10** illustrates the grasping arm continues to be rotated in a counter clockwise direction, and a nozzle being in a high position.

FIG. **11** illustrates the grasping arm continues to be rotated in a counter clockwise direction, and a nozzle being in a middle position.

FIG. **12** illustrates the grasping arm continues to be rotated in a counter clockwise direction, and a nozzle being in a low level.

FIG. **13** illustrates the grasping arm continues to be rotated in a counter clockwise direction, and a nozzle being in a lowest level.



FIG. **14** illustrates the grasping arm continues to be rotated in a clockwise direction, and a nozzle being the lowest level.

FIG. **15** illustrates the grasping arm continues to be rotated in a clockwise direction, and a nozzle being the low level.

FIG. **16** illustrates the grasping arm continues to be rotated in a clockwise direction, and a nozzle being the bottom level.

FIG. **17** illustrates the grasping arm continues to be rotated in a clockwise direction, and a nozzle being the high level.

FIG. **18** illustrates the grasping arm continues to be rotated in a clockwise direction, and a nozzle being left the pill storage case.

FIG. **19** illustrates the grasping arm continues to be rotated in a clockwise direction, and a nozzle being the high level.

FIGS. **20-22** are a flowchart of one embodiment of a method of grasping a pill.

## DETAILED DESCRIPTION

The disclosure is illustrated by way of example and not by way of limitation in the figures of the accompanying drawings in which like references indicate similar elements. It should be noted that references to "an" or "one" embodiment in this disclosure are not necessarily to the same embodiment, and such references mean "at least one."

FIGS. **1-5** illustrate an embodiment of an automatic pill grasping apparatus. The automatic pill grasping apparatus includes an enclosure **100**, a controlling chip **200**, a pill storage mechanism **300**, a pill grasping mechanism **400**, a humidity detecting module **500**, a pill sensing module **800**, and a user interface **900**. The user interface **900** is electrically connected to the controlling chip **200**, to allow a user to set a time and dose of taking pills. The enclosure **100** includes a base **110**, a bracket **120** engaged with the base **110**, and a top cover **130** covering the bracket **120**.

The controlling chip **200** includes a controlling unit **210**, a torsion force obtaining unit **220**, a time recording unit **230**, a torsion force determining unit **240**, a time determining unit **250**, a pressure determining unit **260**, and a humidity determining unit **270**.

The pill storage mechanism **300** is installed on the base **110** and includes a tray **320**, a plurality of pill storage cases **50**, a pill output case **53**, an actuating mechanism **330**, and a shaking member **340**. The plurality of pill storage cases **50** can store a plurality of pills (not shown), and each of the plurality of pill storage cases **50** has a bar code **57** with an initial number of pills and pill species. The tray **320** is rotatably installed on the base **110** and used to rotate the plurality of pill storage cases **50** and the pill output case **53**. The shaking member **340** is secured to the base **310** and can shake one pill storage case **50** at a time. The actuating mechanism **330** includes a first motor **331** and a plurality of first gears **333**. The first motor **331** can drive the plurality of first gears **333**, and the plurality of first gears **333** is rotatable to rotate the tray **320**. Each pill storage case **50** includes an interior wall **51** which forms a storage cavity **53** (shown in FIG. **8**) for storing pills. The pill storage case **50** defines a pill opening **52** for allowing access to the storage cavity **53** of the pill storage case **50**. The pill output case **53** communicates with outside of the enclosure **100**, and the pills can drop out of the enclosure **100** from the pill output case **53**.

The pill sensing module **800** includes a code reader **810** and a counter **820**. The code reader **810** can obtain an initial number of pills of each of the pill storage cases **50** before grasping the pills. The counter **520** can decrement one from the initial number after the pill grasping mechanism **400** picks one pill.

The humidity detecting module **500** includes a moisture absorber **510** and a moisture sensor **520**. The moisture sensor **520** can sense an actual moisture value of the enclosure **100**. The humidity determining unit **270** can determine if the actual moisture value is greater than a predetermined moisture value. The moisture absorber **510** can absorb moisture in the enclosure **100** when the actual moisture value is greater than the predetermined moisture value.

Referring to FIGS. **1-5**, in at least one embodiment, the pill grasping mechanism **400** includes a grasping arm **10**, a nozzle **13** secured to the grasping arm **10**, a filter **420**, a pump **430**, a pressure sensor **440**, and a driving mechanism **450**. The pump **430** can produce a vacuum in the nozzle **13** so that the nozzle **13** can suck pills. The filter **420** is connected to the pump **430** and the nozzle **13** by a pipe **470** and can filter the vacuum generated by the pump **430**. The pressure sensor **440** can sense an actual pressure value of the pipe **470**.

The driving mechanism **450** includes a second motor **441** and a plurality of second gears **443**. The second motor **441** can rotate the plurality of second gears **443**. The plurality of second gears **443** can rotate the grasping arm **10**.

FIGS. **5-7** show that the grasping arm **10** includes a main arm **11**, a linkage mechanism **12**, a holder **124**, a transfer mechanism **14**, a first blocking member **16**, a second blocking member **15**, and a position sensor **17**.

The main arm **11** is rotatable about a first axis **31** and includes a main body **111**, an installation portion **112**, a breaking portion **113**, and a contacting portion **114**. The main body **111** defines a through hole **1111**. The through hole **1111** is cooperatively bound by two opposite straight walls and two opposite curved walls of the main body **111**. The installation portion **112** extends from an upper end of the main body **111**, and the breaking portion **113** extends from a lower end of the main body **111**. The installation portion **112** is substantially perpendicular to the main body **111**. The contacting portion **114** extends from the lower end of the main body **111** and is adjacent to the breaking portion **113**.

The transfer mechanism **14** includes a transfer cam **141**, a driving shaft **142**, and a driving wheel **143**. The transfer cam **141** is rotatable about a second axis **32**. An end portion of the transfer cam **141** defines a fixing hole **1411**. A first end of the driving shaft **142** is received into the fixing hole **1411**, so that the driving shaft **142** is fixed to the transfer cam **141** and can be rotated about the second axis **32** by the transfer cam **141**. The driving shaft **142** is substantially perpendicular to the transfer cam **141**. The driving wheel **143** is mounted to a second end portion of the driving shaft **142** and is rotatable about the driving shaft **142**. The second axis **32** is higher than the first axis **31**. The transfer cam **141** defines one or more slots **1413** for connecting to a motor (not shown), such that the transfer cam **141** can be rotated about the second axis **32** by the motor.

The second end portion of the driving shaft **142** is received into the through hole **1111** of the main body **111**. Thus, the driving wheel **143** is received into the through hole **1111** of the main body **111**. When the driving shaft **142** is rotated by the transfer cam **141** about the second axis **32**, the driving wheel **143** is rolled along an inner wall of the through hole **1111** of the main body **111**, and drives the main body **111** to rotate about the first axis **31**.

The linkage mechanism **12** includes a first linkage arm **121**, a second linkage arm **122**, and a third linkage arm **123**.

The first linkage arm **121** includes a first connecting end portion **1211**, a first pivot portion **1212**, and a contacting end portion **1213**. The first pivot portion **1212** is pivotably coupled to the installation portion **112** of the main arm **11**. The first linkage arm **121** is rotatable about a third axis **33**. The first connecting end **1211** and the contacting end **1213** are located at opposite sides of the first pivot portion **1212**. The contacting end **1213** includes a protrusion **1214** extending downward.

The second linkage arm **122** includes a second connecting end portion **1221**, a second pivot portion **1222**, and a third connecting end portion **1223**. The second linkage arm **122** is substantially triangular. The second connecting end **1221**, the second pivot portion **1222**, and the third connecting end **1223** are substantially three corners of a triangle. The second pivot portion **1222** is pivotably coupled to the installation portion **112** of the main arm **11**. The second linkage arm **122** is rotatable about a fourth axis **34**.

A first end portion of the third linkage arm **123** is pivotably coupled to the first connecting end **1211** of the first linkage arm **121**. A second end portion of the third linkage arm **123** is pivotably coupled to the second connecting end **1221** of the second linkage arm **122**. When the first linkage arm **121** is rotated about the third axis **33**, the third linkage arm **123** is moved by the first linkage arm **121**, thus driving the second linkage arm **122** to rotate about the fourth axis **34**.

The holder **124** includes a third pivot portion **1241**, a shovel **1242**, and a receiving portion **1243**. The third pivot portion **1241** is pivotably coupled to the third connecting end **1223** of the second linkage arm **1221**. The holder **124** is rotatable about a fifth axis **35**. The nozzle **13** is received and mounted in the receiving portion **1243**. The shovel **1242** is located on an outer side of the receiving portion **1243**. A length of the shovel **1242** is greater than a length of the receiving portion **1243**. The shovel **1242** is substantially flat. The nozzle **13** is connected to the pump **420** to suck a pill from the pill storage case **50**.

In one embodiment, the linkage mechanism **12** includes a cover **125**. The cover **125** is mounted to the second linkage arm **122** and the third linkage arm **123**. The cover **125** covers a gap (not labeled) between the second linkage arm **122** and the third linkage arm **123** to prevent a pill from getting stuck in the gap.

The position sensor **17** is substantially U-shaped. The position sensor **17** includes a signal transmitter **171** and a signal receiver **172**. The signal transmitter **171** and the signal receiver **172** face each other. The signal transmitter **171** transmits a signal, e.g., an optical signal, to the signal receiver **172**. When the breaking portion **113** of the main arm **11** is moved to a position between the signal transmitter **171** and the signal receiver **172**, the breaking portion **113** blocks signal transmission between the signal transmitter **171** and the signal receiver **172**, so that the position sensor **17** determines that the main arm **11** is in a predetermined initial position. When the breaking portion **113** of the main arm **11** is not located between the signal transmitter **171** and the signal receiver **172**, the signal transmission recommences, so the position sensor **17** determines that the main arm **11** has left the predetermined initial position.

When the main arm **11** is in the predetermined initial position, the contacting portion **114** of the main arm **11** abuts against the second blocking member **15**, thereby preventing the main arm **11** from rotating about the first axis **31** in a clockwise direction (in FIG. **8**). In one embodiment, the second blocking member **15** is flat and horizontal.

The first blocking member **16** is located on a top wall of the pill storage case **50** and is adjacent to the pill opening **52** of the pill storage case **50**. The first blocking member **16** includes a contacting surface **161**, which is inclined relative to the top wall **54**. In one embodiment, a lower edge of the blocking member **16** is located below the first axis **31**, and a top edge of the blocking member **16** is located above the first axis **31**.

When the main arm **11** is moved in a counter-clockwise direction (in FIGS. **12-15**) to a position where the contacting end **1213** of the first linkage arm **121** abuts against the contacting surface **161** of the first blocking member **16**, and the main arm **11** continues moving in the counter-clockwise direction, the blocking member **16** drives the first linkage arm **121** to rotate about the third axis **33** in a counter-clockwise direction, and further drives the third linkage arm **123** to rotate about the fourth axis **34** in a counter-clockwise direction.

In some embodiments, a radius of rotation of the main arm **11** about the first axis **31** is three times greater than a radius of rotation of the driving shaft **142** about the second axis **32**. A vertical distance between the first axis **31** and the second axis **32** is three and a half times greater than a horizontal distance between the first axis **31** and the second axis **32**.

In one embodiment, the pill grasping mechanism **400** includes a first resilient member **21** and a second resilient member **22**. A first end of the first resilient member **21** is connected to the first arm **11**, and a second end of the first resilient member **21** is connected to the first linkage arm **121**. The first resilient member **21** applies a pulling force to the first linkage arm **121**, so that the first linkage arm **121** is biased to rotate about the third axis **33** in a clockwise direction. A first end of the second resilient member **22** is connected to the first linkage arm **121**, and a second end of the second resilient member **22** is connected to the holder **124**. The second resilient member **22** applies a pulling force to the holder **124**, so that the holder **124** is biased to rotate about the fifth axis **35**. The first resilient member **21** and the second resilient member **22** can be extension springs.

The second resilient member **22** is located on an interior side of the third linkage arm **123** and the cover **125**. When the linkage mechanism **12** enters the storage cavity **53** of the pill storage case **50**, the second resilient member **22** is spaced from the pills stored in the pill storage case **50** by the third linkage arm **123** and the cover **125**, so that the second resilient member **22** is prevented from contaminating the pills stored in the pill storage case **50**.

The interior wall **51** of the pill storage case **50** has a curved surface. When the linkage mechanism **12** enters the storage cavity **53** of the pill storage case **50**, the interior wall **51** guides movement of the shovel **1242** of the holder **124**.

In one embodiment, the first axis **31**, the second axis **32**, the third axis **33**, the fourth axis **34**, and the fifth axis **35** are substantially parallel to each other.

FIGS. **8-19** illustrate a process of the pill grasping mechanism **400** grasping a pill from the pill storage case **50**.

In FIG. **8**, the main arm **11** is in the predetermined initial position. The contacting portion **114** of the main arm **11** abuts against the second blocking member **15**. The blocking member **15** prevents the main arm **11** from rotating about the first axis **31** in the clockwise direction. The breaking portion **113** of the main arm **11** is located between the signal transmitter **171** and the signal receiver **172**, and breaks the signal transmission between the signal transmitter **171** and the signal receiver **172**. Thus, the position sensor **17** determines that the main arm **11** is in the predetermined initial position.

In FIG. **9**, the transfer cam **141** of the transfer mechanism **14** starts rotating about the second axis **32** in a counter-clockwise direction. The driving wheel **143** of the transfer mechanism **14** rolls along an inner wall of the through hole **1111** of the main arm **11**, thus driving the main arm **11** to rotate about the first axis **31** in a counter-clockwise direction. The linkage mechanism **12** and the nozzle **13** are just about to enter the storage cavity **53** of the pill storage case **50**, and the breaking portion **113** of the main arm **11** is just about to leave the position sensor **17**.

In FIG. **10**, the transfer cam **141** of the transfer mechanism **14** continues rotating about the second axis **32** in a counter-clockwise direction. The driving wheel **143** of the transfer mechanism **14** continues rolling along the inner wall of the through hole **1111** of the main arm **11**, and driving the main arm **11** to rotate about the first axis **31** in a counter-clockwise direction. The linkage mechanism **12** and the nozzle **13** enter the storage cavity **53** of the pill storage case **50**. The breaking portion **113** of the main arm **11** leaves the position sensor **17**, thereby enabling the signal transmission between the signal transmitter **171** and the signal receiver **172** to recommence. Thus, the position sensor **17** determines that the main arm **11** has left the predetermined initial position. In this position, the nozzle **13** can pick a pill from a high level of the storage cavity **53** when the storage cavity **53** is fully filled with pills.

In FIG. **11**, when the nozzle **13** does not pick a pill in the high position, the transfer cam **141** of the transfer mechanism **14** continues rotating about the second axis **32** in a counter-clockwise direction. The driving wheel **143** of the transfer mechanism **14** continues rolling along the inner wall of the through hole **1111** of the main arm **11**, and driving the main arm **11** to rotate about the first axis **31** in a counter-clockwise direction. The shovel **1242** of the holder **124** contacts the curved surface of the interior wall **51** and moves along the curved surface under the guidance of the interior wall **51**. In this position, the nozzle **13** can pick a pill from a middle level of the storage cavity **53** when the storage cavity **53** is half full.

In FIG. **12**, when the nozzle **13** does not pick a pill from the middle level, the transfer cam **141** of the transfer mechanism **14** continues rotating about the second axis **32** in a counter-clockwise direction. The driving wheel **143** of the transfer mechanism **14** continues rolling along the inner wall of the through hole **1111** of the main arm **11**, and driving the main arm **11** to rotate about the first axis **31** in a counter-clockwise direction. The protrusion **1214** of the contacting end **1213** of the first linkage arm **121** abuts against the contacting surface **161** of the first blocking member **16**. The first blocking member **16** drives the first linkage arm **121** to rotate about the third axis **33** in a counter-clockwise direction. The shovel **1242** continues moving along the interior wall **51**. In this position, the nozzle **13** can pick a pill from a low level of the storage cavity **53** if the storage cavity **53** is almost empty of pills.

In FIG. **13**, when the nozzle **13** does not pick a pill from the low level, the transfer cam **141** of the transfer mechanism **14** continues rotating about the second axis **32** in a counter-clockwise direction. The driving wheel **143** of the transfer mechanism **14** continues rolling along the inner wall of the through hole **1111** of the main arm **11**, and driving the main arm **11** to rotate about the first axis **31** in a counter-clockwise direction. The first blocking member **161** continues driving the first linkage arm **121** to rotate about the third axis **33** in a counter-clockwise direction, and the shovel **1242** continues moving along the interior wall **51**. In this position, the nozzle **13** can pick a pill from a lowest level of the storage cavity **53**.

In FIG. **14**, when the nozzle **13** does not pick a pill from the lowest level, the transfer cam **141** of the transfer mechanism **14** continues rotating about the second axis **32** in a counter-clockwise direction. The driving wheel **143** of the transfer mechanism **14** continues rolling along the inner wall of the through hole **1111** of the main arm **11**, and driving the main arm **11** to rotate about the first axis **31** in a counter-clockwise direction. The first blocking member **161** continues driving the first linkage arm **121** to rotate about the third axis **33** in a counter-clockwise direction. The shovel **1242** of the holder

124 moves to the right and up level under the guidance of the interior wall 51, until the nozzle 13 picks a pill in the storage cavity 53 of the pill storage case 50.

When the nozzle 13 has picked a pill from the pill storage case 50, the transfer cam 141 of the transfer mechanism 14 starts rotating about the second axis 32 in a clockwise direction. The driving wheel 143 of the transfer mechanism 14 rolls along the inner wall of the through hole 1111 of the main arm 11, and drives the main arm 11 to rotate about the first axis 31 in a clockwise direction.

In FIG. 15, the transfer cam 141 of the transfer mechanism 14 continues rotating about the second axis 32 in a clockwise direction. The driving wheel 143 of the transfer mechanism 14 continues driving the main arm 11 to rotate about the first axis 31 in a clockwise direction. The shovel 1242 and the nozzle 13 move to the bottom position of the storage cavity 53 of the pill storage case 50.

FIG. 16 shows the transfer cam 141 of the transfer mechanism 14 continuing to rotate about the second axis 32 in a clockwise direction. The driving wheel 143 of the transfer mechanism 14 continues driving the main arm 11 to rotate about the first axis 31 in a clockwise direction. The shovel 1242 and the nozzle 13 move to the lowest position of the storage cavity 53 of the pill storage case 50.

In FIG. 17, the transfer cam 141 of the transfer mechanism 14 continues rotating about the second axis 32 in a clockwise direction. The driving wheel 143 of the transfer mechanism 14 continues driving the main arm 11 to rotate about the first axis 31 in a clockwise direction. The shovel 1242 and the nozzle 13 move up from the lowest position of the storage cavity 53 of the pill storage case 50.

In FIG. 18, the transfer cam 141 of the transfer mechanism 14 continues rotating about the second axis 32 in a clockwise direction. The driving wheel 143 of the transfer mechanism 14 continues driving the main arm 11 to rotate about the first axis 31 in a clockwise direction. At this point, the shovel 1242 and the nozzle 13 have left the storage cavity 53 of the pill storage case 50. The breaking portion 113 of the main arm 113 is about to move to interrupt the line between the signal transmitter 171 and the signal receiver 172.

In FIG. 19, the main arm 11 returns to the predetermined initial position. The contacting portion 114 of the main arm 11 abuts against the second blocking member 15. The second blocking member 15 prevents the main arm 11 from rotating about the first axis 31 in a clockwise direction. The breaking portion 113 of the main arm 113 is located between the signal transmitter 171 and the signal receiver 172 and breaks the signal transmission between the signal transmitter 171 and the signal receiver 172. Thus, the position sensor 17 determines that the main arm 11 is in the predetermined initial position. The transfer cam 141 of the transfer mechanism 14 stops rotating, and the driving wheel 143 of the transfer mechanism 14 stops driving the main arm 11 to rotate accordingly.

Referring to FIGS. 4 and 20-22, a pill grasping method comprises the following blocks. The pill grasping method is implemented after the patient sets a time and dose of each kind of pill.

In block 701, the driving mechanism 450 rotates the grasping arm 10 with the nozzle 13 to the predetermined initial position.

In block 702, the actuating mechanism 330 rotates the tray 320 to position the corresponding pill storage case 50 in a predetermined pill grasping position, to allow the grasping arm 10 to pick pills from the pill storage case 50.

In block 703, the driving mechanism 450 rotates the grasping arm 10 to enter into the corresponding pill storage case 50. The torsion force obtaining unit 220 obtains the actual torsion force value of the second motor 441 of the driving mechanism 450, and the time recording unit 230 records the actual time of grasping pill of the grasping arm 10.

In block 704, the pump 430 is turned on to generate a vacuum in the nozzle 13 to suck a pill, and the pressure sensor 440 senses an actual pressure value of the pipe 470.

In block 705, the pressure determining unit 260 determines if the actual pressure value is less than a predetermined pressure value. The actual pressure value is less than the predetermined pressure value when the nozzle 13 sucks the pill. When the actual pressure value is less than the predetermined pressure value, and the method goes to block 706. Otherwise, the method goes to block 801.

In block 706, the driving mechanism 450 rotates the grasping arm 10 to the predetermined initial position.

In block 707, the pressure determining unit 260 determines if the actual pressure value is less than the predetermined pressure value. When the actual pressure value is less than the predetermined pressure value, the method goes to block 708. When the actual pressure value is greater than or equal to the predetermined pressure value, the method goes to the block 703.

In block 708, the actuating mechanism 330 rotates the tray 320 to position the pill output case 53 in the predetermined grasping pill position.

In block 709, the pump 430 is turned off, and the pill sucked by the nozzle 13 drops into the pill output case 53 and slides out of the enclosure 100.

In block 710, an alarm is sent.

When the pressure value is greater than the predetermined pressure, the method further includes block 801.

In block 801, the torsion force determining unit 240 determines if the actual torsion force value is greater than a predetermined limitation value. If the actual torsion force value is greater than the predetermined limitation value, the method goes to block 802. Otherwise, the method goes to the block 704.

In block 802, the driving mechanism 450 rotates the grasping arm 10 to the predetermined initial position.

In block 803, the time determining unit 250 determines if the actual time is greater than a predetermined time. If the actual time is greater than the predetermined time, the method goes to block 804. Otherwise, the method goes to the block 703.

In block 804, the controlling chip 200 starts the shaking member 340. The shaking member 340 shakes the pill storage case 50 for a predetermined time duration and sets the actual time to zero, then the method goes to the block 703.

It is to be understood that even though numerous characteristics and advantages have been set forth in the foregoing description of embodiments, together with details of the structures and functions of the embodiments, the disclosure is illustrative only and changes may be made in detail, including in the matters of shape, size, and arrangement of parts within the principles of the disclosure. The disclosed embodiments are illustrative examples, and are not intended to limit the scope of the following claims.

What is claimed is:

1. A pill grasping method, the method comprising:

rotating a grasping arm with a nozzle to a predetermined initial position driven by a driving mechanism;

rotating a plurality of pill storage cases to locate one of the plurality of pill storages with a set pill species to a predetermined grasping pill position driven by an actuating mechanism;

rotating the grasping arm to stretch into the one of the plurality of pill storage case;

starting a pump to generate a vacuum to the nozzle for sucking a pill;

determining if an actual pressure value in a pipe connecting the nozzle to the pump being less than a predetermined pressure value; and

rotating the grasping arm to the predetermined initial position when the actual pressure is less than the predetermined pressure value;

wherein after the block of rotating a plurality of pill storage cases to locate one of the plurality of pill storages with a set pill species to a predetermined grasping pill position and before the block of starting a pump to generate a vacuum to the nozzle for sucking a pill, the method further comprises:

obtaining an actual torsion force value of the driving mechanism;

determining if the actual pressure value is less than the predetermined pressure value;

determining if the actual torsion force value is greater than a predetermined limitation value when the actual pressure value is not less than the predetermined pressure value; and

rotating the grasping arm to the predetermined initial position when the actual torsion force value is greater than the predetermined limitation value.

**2**. The pill grasping method of claim **1**, wherein after the block of rotating the grasping arm to the predetermined initial position when the actual pressure is less than the predetermined pressure value, the method further comprises:

determining if the actual pressure value is less than the predetermined pressure value;

rotating a pill output case to the predetermined grasping pill position when the actual pressure value is not less than the predetermined pressure value;

powering off the pump to drop out of the pill to the pill output case; and

sending a notice signal.

**3**. The pill grasping method of claim **2** further comprising:

rotating the grasping arm to stretch into the one of the plurality of pill storage case when the actual pressure value is greater than the predetermined pressure value.

**4**. The pill grasping method of claim **1**, wherein after the block of rotating the grasping arm to stretch into the one of the plurality of pill storage case before the block of determining if an actual pressure value in a pipe connecting the nozzle with the pump being less than a predetermined pressure value, the method further comprises:

sensing the actual pressure value of the pipe.

**5**. The pill grasping method of claim **1**, wherein after the block of rotating a plurality of pill storage cases to locate one of the plurality of pill storages with a set pill species to a predetermined grasping pill position and before the block of starting a pump to generate an vacuum to the nozzle for suck a pill, the method further comprises:

recording an actual time of the grasping arm;

determining if the actual time is greater than a predetermined time;

starting a shaking member to shake the one of the plurality of pill storage case when the actual time is greater than the predetermined time; and

setting the actual time to zero.

**6**. The pill grasping method of claim **5** further comprising:

rotating the grasping arm to stretch into the one of the plurality of pill storage case when the actual time is not greater than the predetermined time.

**7**. The pill grasping method of claim **1** further comprising:

rotating the grasping arm to stretch into the one of the plurality of pill storage case when the torsion force value is greater than the predetermined limitation value.

**8**. An automatic pill grasping apparatus, comprising:

a base;

a pill grasping mechanism comprising a grasping arm, a nozzle, and a driving mechanism, the grasping arm being rotatably installed on the base, the driving mechanism attached to the base; and

a pill storage mechanism comprising a plurality of pill storage cases for storing pills, and an actuating mechanism; the plurality of pill storage cases being rotatably secured to the base, and the actuating mechanism being attached to the base,

wherein the plurality of pill storage cases is rotatable relative to the base driven by the actuating mechanism, the grasping arm is rotatable relative to the base to stretch the nozzle into one of the plurality of pill storage cases to suck pills; and

wherein the grasping arm comprises a main arm and a linkage mechanism pivotably mounted to the main arm, the main arm being rotatable about a first axis, the linkage mechanism further comprises a holder which is pivotable relative to the main arm, and the nozzle is mounted to the holder.

**9**. The automatic pill grasping apparatus of claim **8**, wherein the pill grasping mechanism further comprises a pump, and a pipe, the pipe is connected to the pump and the nozzle, and the pump is configured to generate vacuum to the nozzle through the pipe.

**10**. The automatic pill grasping apparatus of claim **9**, wherein the pill grasping mechanism further comprises a filter, and the filter is configured to filter the vacuum.

**11**. The automatic pill grasping apparatus of claim **8**, wherein the grasping arm further comprises a transfer mechanism; the main arm defines an opening, the transfer mechanism comprises a transfer cam being rotatable about a second axis and a driving wheel mounted to the transfer cam and received in the opening of the main arm, when the transfer cam rotates about the second axis, the driving wheel is rotated about the second axis by the transfer cam and is adapted to press an edge of the opening of the main arm and to drive the main arm to rotate about the first axis.

**12**. The automatic pill grasping apparatus of claim **11**, wherein the transfer mechanism further comprises a driving shaft secured to the transfer cam, the driving wheel is mounted to a free end of the driving shaft, the free end of the driving shaft extends into the opening of the main arm, when the transfer cam rotates about the second axis, the driving shaft is rotated about the second axis by the transfer cam.

**13**. The automatic pill grasping apparatus of claim **12**, wherein the first axis is substantially parallel to the second axis.

**14**. The automatic pill grasping apparatus of claim **13**, wherein a vertical distance between the first axis and the second axis is three and one half times greater than a horizontal distance between the first axis and the second axis.

**15**. The automatic pill grasping apparatus of claim **13**, wherein the transfer cam defines one or more slots for connecting to a motor, the transfer cam is rotated by the motor.

**16**. The automatic pill grasping apparatus of claim **13**, wherein a radius of rotation of the main arm about the first axis is three times greater than a radius of rotation of the driving shaft about the second axis.

**17**. The automatic pill grasping apparatus of claim **13**, wherein the linkage mechanism further comprises a first link-

age arm, a second linkage arm, and a third linkage arm, the first linkage arm and the second linkage arm are pivotably mounted to the main arm, a first end of the third linkage arm is pivotably mounted to the first linkage arm, a second end of the third linkage arm is pivotably mounted to the second linkage arm, and the holder is pivotably mounted to the second linkage arm.

**18**. The automatic pill grasping apparatus of claim **17**, wherein the holder comprises a receiving portion for receiving the nozzle and a shovel located on an outer side of the receiving portion.

**19**. The automatic pill grasping apparatus of claim **17**, further comprising a first blocking member, wherein when the main arm rotates to a position where the first linkage arm abuts against the first blocking member, the first blocking member is adapted to drive the first linkage arm to rotate relative to the main arm.

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